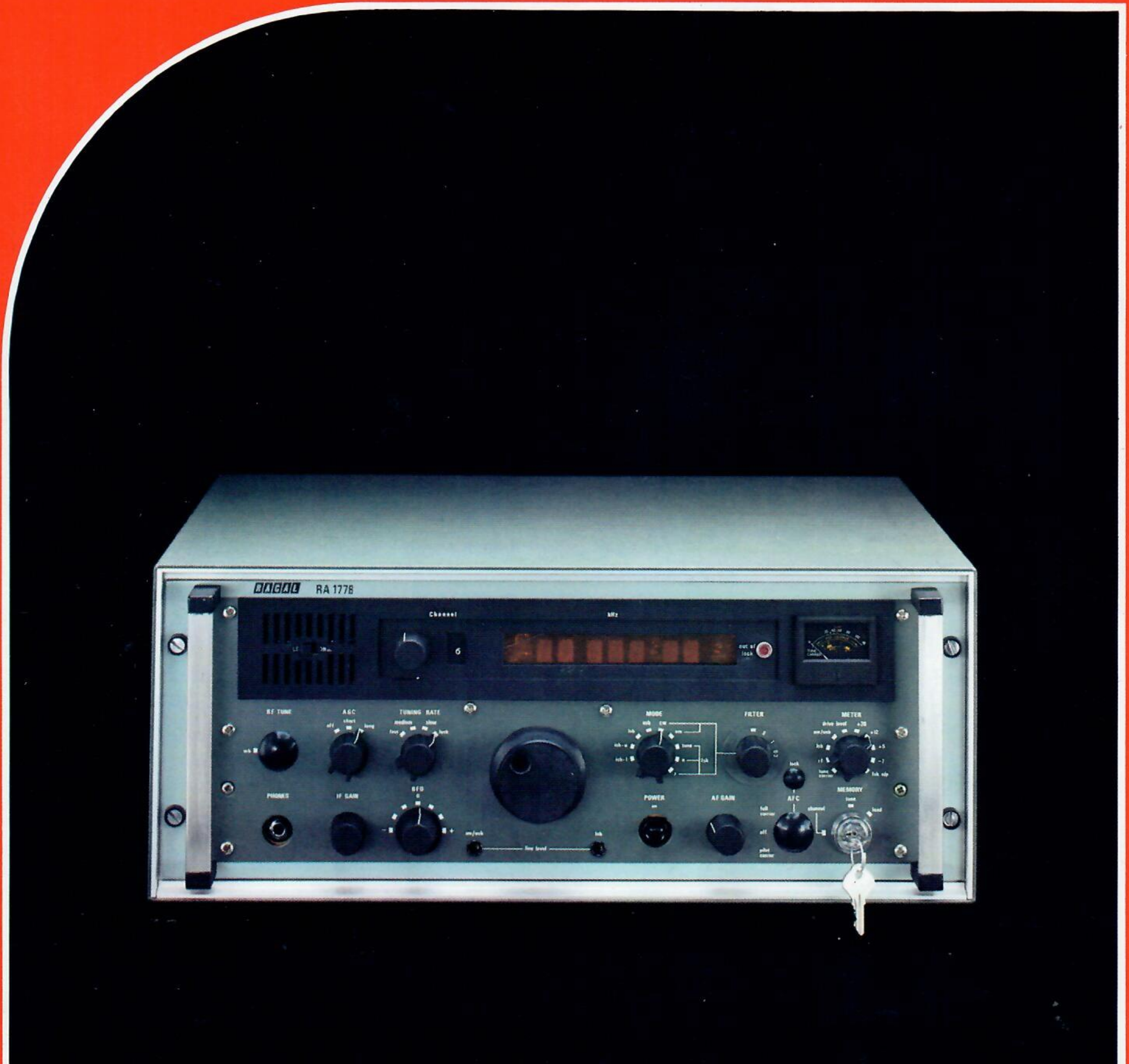
RA 1778

Programmable synthesized communications receiver

Frequency range 15 kHz to 30 MHz in 10 Hz increments
Twelve programmable channels
Single knob electronic tuning of fast switching synthesizer
Three-speed electronically selected tuning rate
Intermodulation products better than –90 dB
Unsurpassed signal path performance
Built-in options for ISB, FSK and AFC
Optional RF tuning – choice of frequency standards
High MTBF – low MTTR

Racal Communications Limited



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Programmable synthesized LF/MF/HF communications receiver type RA 1778

The Racal RA 1778 programmable communications receiver is designed for full local operator control and is suitable for all forms of reception within the frequency range 15 kHz to 30 MHz. It is fully synthesized and has a built in memory unit which may be programmed with up to 12 frequencies selected by a front panel mounted rotary switch.

A rechargeable nickel-cadmium cell provides the power for the memory circuits so that the programmed frequency information is stored even during extended main power supply failures.

The well proven single knob frequency control is retained to allow the receiver to be tuned continuously across its working range with the smoothness and feel of a VFO while maintaining the stability and accuracy of the in built frequency standard.

The RA 1778 combines all the advantages and feel of full manual operator control with rapid switching of selected frequencies in constant demand. Any of the 12 channels can be reprogrammed from the front panel at any time without specialized test gear or training. A seven digit LED readout is used to indicate the tuned frequency with a resolution of 10 Hz. Facilities are provided for inhibiting the frequency readout.

A key operated switch on the receiver front panel ensures that no programmed channel is inadvertently erased. This same switch is also used when entering new frequencies into the memory.

The RA 1778 embodies the latest techniques in electronic design and production based on the company's experience with the highly successful RA 1770 series. Performances with respect to dynamic range, intermodulation products, reciprocal mixing, cross modulation, blocking and spurious responses are far better than those of contemporary receivers.

The receiver will accomodate a total of six filters. Two may be asymmetrical SSB/ISB with either 3 kHz or 6 kHz nominal bandwidths, leaving space for fitting IF selectivity filters or AFC carrier filter, according to user requirements. Additional positions for IF selectivity filters become available if SSB/ISB filters are not fitted.

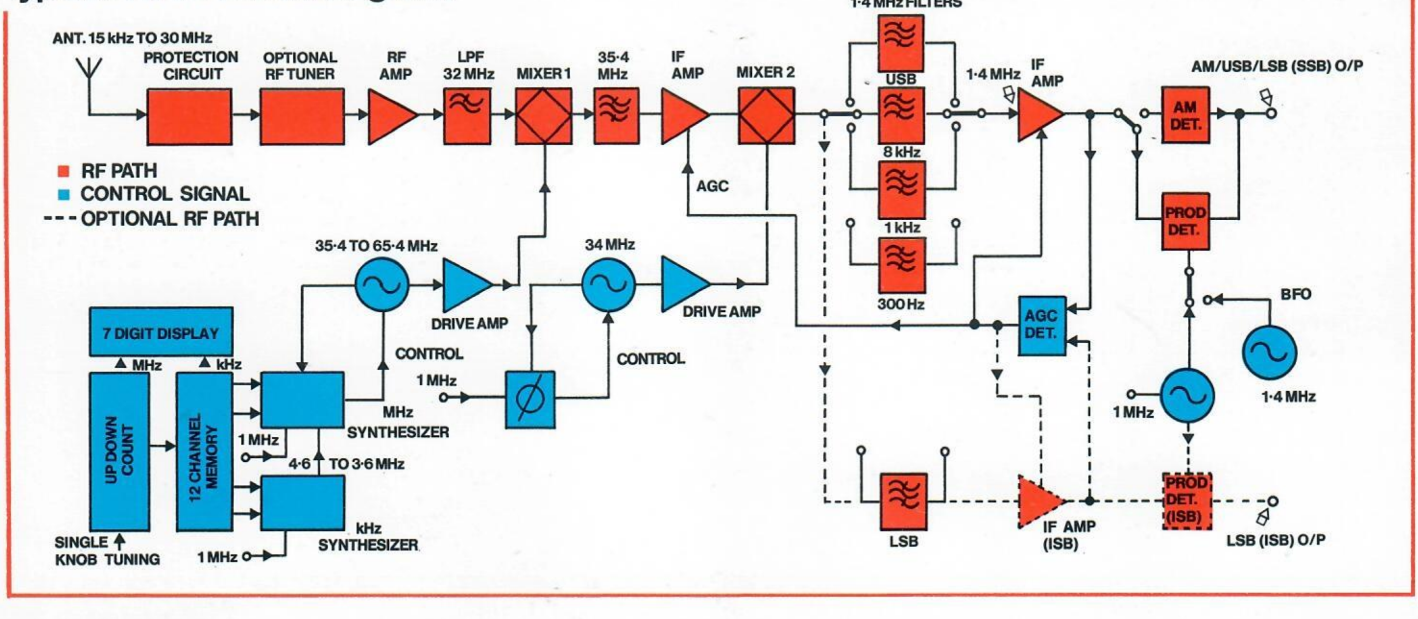
For CW operation a BFO with a range of ± 3 kHz is fitted, a slow motion drive providing extremely smooth control.

In addition to the normal modes of reception provided in the basic receiver, optional units may be fitted within the main receiver frame to permit reception of ISB and FSK signals as well as AFC operation. Although the standard version of the receiver is fitted with a wideband RF amplifier unit a tuned unit is also available as an alternative when additional pre-selection is considered necessary.

The high stability of the RA 1778 is achieved by a frequency synthesizer referenced to a built-in frequency standard which in the basic model is a temperature compensated crystal oscillator (TCXO). For applications demanding higher orders of accuracy particularly over wide operating temperature ranges alternative units such as the Racal 9400 series of proportionally controlled ovened crystal oscillators can be supplied as optional extras.

Alternatively the receiver may be locked to any external frequency standard with an output at 1 MHz.

Type RA 1778 Block diagram



Principle of Operation

The simplified block diagram shows the basic principle of operation of the RA 1778 Receiver.

The input signal is fed from the antenna via a protection circuit to a linear RF stage. After amplification it passes via a 32 MHz low pass filter to the first mixer where it is combined with a variable frequency output from the synthesizer. This frequency in the 35.4 to 65.4 MHz range, is selected by the front panel control and is dependent on the frequency of operation. The synthesizer is tuned in 10 Hz, 20 Hz or 1 kHz increments.

The IF output from the first mixer is fed via a 35.4 MHz band pass filter and an IF amplifier to the second mixer, where it is combined with a 34 MHz output from the synthesizer to provide a 1.4 MHz IF output. Dependent upon the mode selected, the 1.4 MHz signal is then fed to the SSB or IF selectivity filters.

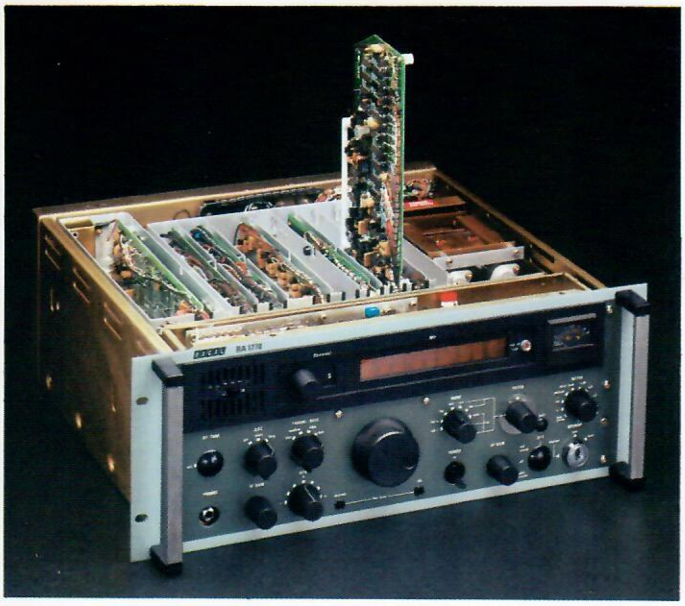
The output from the selected filter passes via the main IF amplifier to an AGC amplifier and detector which controls the gain of the various IF amplifier stages, and to the detector stage. A product detector is provided for CW/SSB modes and an envelope detector for DSB. For CW a variable BFO is provided whose frequency can be varied ± 3 kHz from the 1.4 MHz IF. For SSB or ISB reception a 1.4 MHz output derived from the frequency standard provides a reinserted carrier.

In the ISB mode two identical IF and AF amplifiers provide separate upper and lower sideband outputs.

The flexibility of the receiver is assured by the provision of a further selection of optional items which may be added externally. A bandpass filter for fitting into the antenna system, a telephony switching unit for speech diversity systems and a 1.4 MHz to 100 kHz IF conversion unit are among the modules available at extra cost. Comprehensive input and output connectors on the rear panel provide access to the various facilities and options so that the RA 1778 may be used in complex receiver systems. When fitted with the FSK module direct connection may be made to 2 teleprinters without the need for external telegraph power supply units or line protection circuits.

A switched monitor loudspeaker and front panel headphone jack are provided in addition to comprehensive metering facilities for the indication of RF level, AF level, FSK tune and supply voltage levels. A self contained power supply unit permits operation from 100 – 125/200 – 250 V AC mains.

The mechanical construction used provides a very robust receiver capable of operating under extreme environmental conditions. The receiver is extremely compact and normally supplied as a standard rack mounting unit. Bench mounting cabinets, which must be ordered separately, are also available with a choice between the commercial type, a ruggedized marine version and a mobile/transportable model.



Ease of accessibility is a feature of the RA 1770 series receivers. The circuit boards may be raised into the position shown for test and maintenance purposes.

Technical Specification

The performance as stated in this specification is applicable to the wideband condition only. If the optional RF tuning unit is fitted an additional 20 dB of protection is given at ±12½% off-tune with an insertion loss up to 2 dB and consequent modification to specification.

Frequency range
15 kHz – 30 MHz.

Modes of reception
A1, A2, A2H, A2J, A3, A3A, A3J, A3H with the following options:
(i) Choice of USB or LSB.
(ii) Provision for reception of A3B or F1.
(iii) Provision of AFC.

Tuning
(a) 12 Programmable channels.
(b) Continuously tunable synthesizer in 10 Hz, 20 Hz or 1 kHz increments over the full frequency range.
Seven digit electronic readout.

Tuning accuracy
± 5 Hz relative to the frequency of the wanted signal.

Frequency stability
(1) The following optional alternative frequency standards may be fitted:
(a) Temperature Controlled Crystal Oscillator (TCXO).
(i) Temperature: Better than ± 1.5 in 10^6 from –10°C to 55°C.
(ii) Long Term: ± 2 in 10^7 over a 30 day period.
(b) Frequency Standard Type 9400.
(i) Temperature: ± 1 in 10^8/°C.
(ii) Long Term: ± 1.5 in 10^7 over a 30 day period or ± 5 in 10^9 per day.
(c) Frequency Standard Type 9420.
(i) Temperature: ± 6 in 10^{10}/°C.
(ii) Long Term: ± 1.5 in 10^8 over a 30 day period or ± 5 in 10^{10} per day.
(2) Provision is made for the use of an external frequency standard. 1 MHz >0dBm into 50 ohms.

Antenna input
(a) Wideband. 50 ohms to 75 ohms nominal. BNC coaxial connector.
(b) RF tuning is available as an optional fitting within the receiver. This is provided by five automatically selected bandpass filters covering the frequency range 1 MHz to 30 MHz. Manual RF peak tuning is provided over each pre-selected band of frequencies. Each tuned range provides a nominal attenuation of 20 dB at 12½% off-tune. A low pass filter is used below 1 MHz.
(c) Receiver muting is provided to protect the receiver from local emissions on the tuned frequency. The operation of the muting circuits permits 'break in' or 'listen through' operation when keying at a rate of up to 20 bauds.
(d) The receiver will withstand without damage RF input signals of 30 V (EMF) continuously. A fuse and spark gap is provided for protection against higher voltages.
(e) Re-radiation with the antenna input terminated in 50 ohms is less than 10 microvolts.

Rear view of RA 1778 receiver showing connectors and other user facilities.

Technical Specification (continued)

Sensitivity
(a) CW and SSB (A1, A2H, A3A, A3H, A3J).
In a 3 kHz bandwidth the signal-to-noise ratio is better than:
500 kHz – 30 MHz, 15 dB with 1 μV (EMF) input.
50 kHz – 500 kHz, 15 dB with 3 μV (EMF) input.
15 kHz – 50 kHz, 15 dB with 10 μV (EMF) input.
(b) DSB (A2, A3).
In a 3 kHz bandwidth the signal-to-noise ratio is better than:
500 kHz – 30 MHz, 15 dB with 1.5 μV (EMF) input 70% modulated.
50 kHz – 500 kHz, 15 dB with 5 μV (EMF) input 70% modulated.
15 kHz – 50 kHz, 15 dB with 15 μV (EMF) input 70% modulated.

IF selectivity
(a) SSB (A3A, A3J).
Passband at –6dB: 250 Hz to 3000 Hz.
Passband at –60 dB: –400 Hz and +4100 Hz.
Or alternatively
Passband at –6dB: 250 Hz to 6000 Hz.
Passband at –60 dB: –300 Hz and +8000 Hz.
(b) ISB (A3B).
Passband at –6 dB: 250 Hz to 3000 Hz.
Passband at –60 dB: –400 Hz and +4100 Hz.
or alternatively
Passband at –6 dB: 250 Hz to 6000 Hz.
Passband at –60 dB: –300 Hz and +8000 Hz.
(c) CW/MCW/AM/FSK (A1, A2, A3, A2H, A3H, F1).
Standard Receivers. In addition to the mode-selected SSB or ISB filters, up to four optional IF filters may be fitted although certain combinations of facilities will permit only three filters to be fitted. IF filters of the following nominal passbands are available.:
0.3 kHz, 1 kHz, 3 kHz, 6 kHz, 8 kHz, 13 kHz,.
Alternative filters can be supplied to special order.

Cross modulation
With a wanted signal greater than 300μV EMF, in a 3 kHz bandwidth, an unwanted signal, 30% modulated, removed not less than 20 kHz, will be greater than 300 mV EMF, to produce an output 20 dB below the output produced by the wanted signal.

Reciprocal mixing
With a wanted signal of less than 100μV EMF, in a 3 kHz bandwidth, an unwanted signal more than 20 kHz removed will be greater than 70 dB above the wanted signal level to give noise level 20 dB below the output produced by the wanted signal.

Blocking
With a wanted signal of 1 mV EMF, an unwanted signal more than 20 kHz removed must be greater than 500 mV to reduce the output by 3 dB.

Intermodulation products
(a) Out of Band.
With two 30 mV EMF signals separated and removed from the wanted signal by not less than 20 kHz the third order intermodulation products are not less than –85 dB below either of the interfering signals and typically better than –90 dB.
(b) In Band.
Two in band signals of 30 mV EMF will produce third-order intermodulation products of not greater than –40 dB.

Spurious responses
(a) External.
External signals, 20 kHz removed from the wanted signal, must be at least 80 dB above the level of the wanted signal to produce an equivalent output.
(b) Internal.
The specified sensitivity figures in the CW/SSB modes are not reduced by more than 3 dB as a result of any internally generated spurious signals.

AGC
(a) Range.
An increase in input of 100dB above 2 microvolts EMF will produce an output change of less than 6dB.
(b) Switched selection of AGC 'off', 'short' and 'long' time constants.

AFC (A3A, A3B)
(a) AFC is available as an optional internal facility and is provided with a front panel switch for switching AFC in or out of operation.
(b) Capture range: ± 50 Hz.
Follow range: ± 500 Hz or beyond.
Residual Error: 2 Hz max.
Memory: In the event of carrier failure, or worsening of the carrier to noise/modulation level of 10dB, no retuning is necessary for fades of up to 1 minute.

BFO range
± 3 kHz variable by a slow motion control.

IF output (AGC on)
1.4 MHz, nominally 100mV (EMF) into 50 ohms.

Audio characteristics
(a) Output levels:
(i) Line outputs, 1 mW nominal into 600 ohms balanced, adjustable by preset level control on front panel to + 6 dBm.
(ii) Phone outputs unbalanced, 10 mW nominal into 600 ohms.
(iii) 50 mW into an internal loudspeaker which is capable of being switched in or out of operation.
(iv) Connection for external speaker 1 watt into 8 ohms.
(b) AF response:
(i) Line outputs. Within 1 dB from 100 Hz to 6000 Hz relative to the level of a standard 1000 Hz tone.
(ii) The overall AF response will be dependent upon the IF bandwith selected.
(c) AF distortion:
(i) Line outputs. Not greater than 2% at specified output of 1mW nominal.
(ii) Loudspeaker outputs. Not greater than 5% at 50 mW output to internal loudspeaker, and 1 W output to external speaker.
(iii) Phone outputs. Not greater than 5% at specified output of 10 mW nominal.

Cross talk (A3B)
With a wanted signal at a level of 1 mV and the AF output adjusted to 1 mW, the cross talk from an equal signal in the opposite sideband, at greater than 400 Hz from the carrier, is not greater than −50 dB relative to 1 mW.

Frequency shift demodulation (optional)
(a) Frequency shift range, 85 Hz to 850 Hz.
(b) Maximum keying speed 200 bauds.
(c) Telegraph distortion not greater than 5% up to 100 bauds.
(d) Telegraph output. Polar (double current) DC output approximately 100 mA with choice of 6 – 0 – 6 V or 80 – 0 – 80 V. Normally positive on 'Mark'. Provision is made by internal adjustment for neutral (single current) operation.
(e) Mark/space reversal is available to the operator and a 'tune' switch position is provided to permit tuning of the receiver without operating the teleprinter.

Metering
A meter is provided on the front panel to indicate RF level, AF level to line, FSK tune, and suitable performance or supply test levels.

Power supply
100 V–125 V or 200 V–250 V, ± 10%, 45 – 65 Hz.

Power consumption
Approximately 60 VA (Basic receiver).
Approximately 90 VA (Fully equipped).

Environmental conditions
The equipment is designed to meet certain of the requirements of the British Defence Specification DEF 133, L2, for ambient temperature range of:

Operating Temperature	−10°C to +55°C.
Storage Temperature	–40°C to +70°C.
Relative Humidity	95% at 40°C.

Dimensions
Rack Mounted
Height: 178 mm (7 in).
Width: 483 mm (19 in).
Depth: 410 mm (16.15 in).
In Bench Cabinet
Height: 220 mm (8.65 in).
Width: 495 mm (19.5 in).
Depth: 445 mm (17.5 in).

Weight (approx)
Rack Mounted
22 kg (48.5 lb).
In Bench Cabinet
28 kg (61.5 lb).

Accessories

AA 660/A
Headset, 600 ohms, with ventilated ear cushions, lead and plug.
Headsets are also available with standard ear cushions and anti-perspiration covers.

BA 45520
Bench Mounting Cabinet.

DA 47020
Ruggedized Bench Mounting Cabinet for marine applications.

DA 46531
Ruggedized Bench Mounting Cabinet fitted with shock mounts for mobile/transportable applications.

Optional external modules

MM 530
Bandpass filter 2 –30 MHz, for use in receiver antenna systems.

MM 532/1 and MM 532/2
Telephone Diversity Switching Units for SSB and ISB operation respectively.
For use in speech diversity systems.

MS 561/1 and MS 561/2
IF Conversion Modules, 1.4 MHz to 100 kHz for SSB and ISB operation respectively.
Provide 100 kHz output(s) for use with ancillary equipment.

Note:

All accessories and optional facilities and modules to be specified at time of order.

Racal reserve the right to vary in detail from the description and specification in this publication.

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